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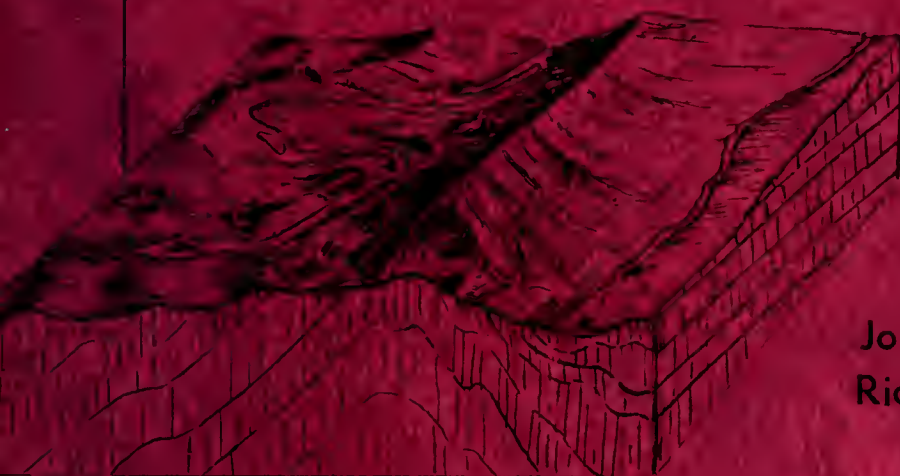


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General Geology Report G30

1971

The Geology of the Hidden Valley
Boy Scout Camp Area
Perry County, Pennsylvania



John T. Miller
Richard B. Wells

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GENERAL GEOLOGY REPORT G30

The Geology of the Hidden Valley Boy Scout Camp Area Perry County, Pennsylvania

by John T. Miller

revised by Richard B. Wells

PENNSYLVANIA GEOLOGICAL SURVEY

FOURTH SERIES

HARRISBURG

1st edition 1957

2nd edition 1971

PY G345/4.3 G30 1971 c.1
Miller, J. T. 1906-
The Geology of the Hidden
Valley Boy Scout Camp Area,

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PREFACE

This book is a field guide to the geology of the Hidden Valley area. It was written to help Boy Scouts and their leaders understand the rocks that are found in the camp, how and when they were formed, how they influence the shape of the land and the ways in which they can be used.

In the book is a geologic map of the Hidden Valley area, which shows the distribution of the various rock formations, and a topographic map of the same area, which shows the shape of the land surface, the location of all the buildings, trails, and roads in camp, and the distances between them. By using these maps and the list of outcrop localities in the Appendix, a Boy Scout, using his compass, can visit the outcrops of each formation to see for himself how they look in the field and make a rock collection of his own.

The Boy Scout who is interested in geology may obtain a copy of the "Geology" Merit Badge Series book, which can be purchased in camp. He may also enjoy reading a booklet entitled "Pennsylvania Geology Summarized", which may be obtained without cost by writing to the Pennsylvania Geological Survey, Harrisburg, Pa. 17120. Ask for Educational Series No. 4.

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THE GEOLOGY OF THE HIDDEN VALLEY BOY SCOUT CAMP AREA PERRY COUNTY, PENNSYLVANIA

by

John T. Miller and Richard B. Wells

AN INTRODUCTION TO GEOLOGY

SIGN POSTS OF GEOLOGY

Historians and archeologists interpret old documents, ancient signs of cities, and the ruins of human cultures to compile a historical account of man. In much the same way, geologists interpret signs which can be seen in rocks to compile the part of the earth's history which occurred before man's appearance on the scene. Minerals and fossils are signs in the rocks, which often enable geologists to read the story of those rocks, and to decipher the history of the earth itself.

Many signs found in the rocks of the Hidden Valley area need to be explained. For example: Why are sea shells found in the rocks? Why do the ledges of rock near camp seem to stand on end? When and how was Bowers Mountain formed? Will the mountain last forever as it is now, or will it gradually be changed by nature? These and many other questions can be answered by examining the rocks of the Hidden Valley area. But first it is necessary to consider some fundamental principles of geology, in order to make the geology of the camp area more easily understood.

TOPOGRAPHY

Topography (to-pág-re-fe) is the shape of the land surface, or the "top" of the ground. A *topographic map* is a two-dimensional, graphic representation of the surface of the earth, on which the topography is shown by using lines of equal elevation called *contour lines*. The difference in elevation between contour lines is called the *contour interval*. On the topographic map of Hidden Valley Boy Scout Camp (Plate I) the contour interval is ten feet. This means that everything located on each contour line is ten feet higher than anything on the next lower contour line. Generally every fifth contour line on a topographic map is labelled with its elevation above sea level.

The first contour line next to the shore of a lake is always parallel to the shoreline, and the path of a contour line on a map may be thought of as the edge of an imaginary body of water, whose surface lies at the same elevation as the contour line.

Topographic maps are used by geologists when working in the field, so that they are always able to locate themselves accurately. They are also useful because the form of the land surface, as shown by the contour lines, usually gives a clue to the nature of the underlying bedrock. For example, shale is a relatively soft rock which is rapidly worn down and eroded, so that it often underlies stream valleys. On the other hand, beds of hard sandstone are more resistant to erosion, and form the higher ridges. There are other reasons for the presence of hills and valleys, but the important thing to remember is that topography is usually a reflection of the bedrock, and can be used to interpret the geology of an area.

THE NATURE OF ROCKS

A rock is a solidified aggregate of mineral particles or grains. Minerals, in turn, are naturally occurring crystalline solids, which have a definite chemical make-up, and a definite set of physical properties. For example, the rock *sandstone* is made of sand-size mineral grains. Ordinarily, most of these grains consist of *quartz*, which is a mineral composed of the chemical elements silicon and oxygen. Thus, ordinary chemical elements combine to form minerals, which in turn, join to form rocks. Physical properties of the minerals, such as hardness, color, luster, and cleavage (or fracture) are characteristic of each mineral, and can be used to identify the minerals. By knowing what minerals are present in a rock a geologist is able to tell what kind of rock he has found.

There are three main groups of rocks: *igneous*, *sedimentary*, and *metamorphic*.

1. Igneous rocks: Igneous means "like fire" and igneous rocks are those which form by the hardening of hot melted rock material called magma or lava. When heat and pressure in the earth cause minerals to melt, the melted material may either flow onto the surface of the earth as lava and form volcanic rocks, or stay below the surface as magma and harden to form granite or some other type of crystalline igneous rock.
2. Sedimentary rocks: Those which originate as sediments deposited or laid down by water or wind are called sedimentary rocks, literally "petrified" sediment. Sediments are accumulations of mud,

sand, or gravel, which consist of grains (or fragments) of older rocks. Common types of sediments which often become sedimentary rocks are stream gravels, beach sands, wind-blown desert sand, mud at the bottom of a bay or swamp, and sea shells which accumulate on the ocean floor. Through time, these sediments become solidified and harden to form sedimentary rocks such as conglomerate, sandstone, shale, and limestone.

3. Metamorphic rocks: Metamorphism means "a change in form", and metamorphic rocks are those which began as either igneous or sedimentary rocks. The heat and pressure of metamorphism cause the mineral particles to recrystallize, so that the final form of a metamorphic rock is often quite different from the original rock. Slate and marble are common metamorphic rocks.

The rocks of the Hidden Valley area are all sedimentary rocks, thus igneous and metamorphic rocks will not be mentioned again.

THE NATURAL HISTORY OF SEDIMENTS

Most sedimentary rocks are formed from sediments that were deposited in water. The sediments are laid down in layers, and it is easy to see why, by thinking of the action of present-day streams and ocean currents. When heavy rains occur, soil and rock fragments are washed into streams from hills and valley sides, making the streams muddy. When a stream floods, and overflows its banks, a layer of sediment is deposited in the flooded area. Some of the mud is carried downstream to the ocean, where it is distributed by currents and deposited in layers on the ocean floor. When another flood occurs, another layer of sediment covers the preceding layer, so that, over the years, a great thickness of sediment may accumulate. As the accumulation of mud and sand gets thicker and thicker, it gradually becomes more compact and harder, until eventually it is transformed into sedimentary rock.

It is common to see leaves, tree branches, and even whole trees carried along by flood waters. Every year many plants and animals are swept away by floods and covered by sediment where they are deposited. Also, fish, shellfish, and other kinds of sea animals become buried by sediment. If deposition is rapid, the plant and animal remains are apt to become petrified and preserved as fossils.

Each layer of sediment represents one period of flooding or deposition, and the topmost layer always represents the youngest or most recent accumulation. The idea that the uppermost layer is the youngest layer is a fundamental law of nature, which geologists call the *Law of*

Superposition. After sediments become sedimentary rock, these layers are called *beds* or *strata*, and the top of each layer is called a *bedding plane*.

Many times in the earth's history, the sediments of coastal areas have been uplifted above sea level by the long, slow processes of mountain building. These processes are occurring now along the shores of the Pacific Ocean in western North and South America, along the east coast of Asia, and throughout the island chains which surround the Pacific Ocean basin. Earthquakes and volcanoes are common in these areas, another sign that there is movement in the crust of the earth. The making of mountains is not a sudden event, but occurs slowly, over a period of millions of years, and it is during these times that sediments containing fossils are lifted thousands of feet above sea level. This is how it is possible to find petrified sea shells on mountain tops.

DESCRIPTION OF SEDIMENTARY ROCKS

Sedimentary rocks can be classified into three principal groups. They are (1) fragmental, (2) chemical, (3) organic.

Fragmental Sedimentary Rocks

These are rocks composed of fragments of pre-existing rocks and minerals, cemented together by any one of several mineral cements. They are classified on the basis of the size of the fragments (or grains) in the rock:

Conglomerate

Rounded fragments of pebble or cobble size (one-tenth of an inch and larger). This rock is a petrified gravel, and usually has a sandy matrix between the pebbles.

Sandstone

Sand-size (less than one-tenth of an inch) grains of quartz or other minerals, usually cemented by lime or silica.

Shale or Claystone

Rocks in which the grains are too small to be seen by the naked eye, formed from the solidification of mud or silt. If the rock splits easily along flat, parallel planes, it is a shale. If not, it is called a claystone or mudstone.

Fragmental Limestone

Gray colored rocks in which fragments of fossils of many different sizes are cemented by lime.

Chemical Sedimentary Rocks

These are rocks which have been deposited chemically (precipitated), usually from sea water.

Limestone

Limestone is usually some shade of gray, and is composed of minute crystals of calcite. Usually the crystals are too small to be seen without a magnifying glass or a microscope. Limestone is deposited in warm, shallow seas, in some fresh water lakes, and in caverns. Limestone can be identified easily by amateur chemists, because a drop of weak hydrochloric acid will cause it to bubble or effervesce.*

Evaporites

Rocks composed of various kinds of salt, such as rock salt, gypsum or anhydrite. They are deposited along the shores of saline bodies of water such as the Great Salt Lake in Utah, and in lagoons along hot, dry desert coastlines, such as in the Caspian Sea. No evaporites have been found in the Hidden Valley area.

Organic Sedimentary Rocks

The word "organic" refers to material that was produced by living organisms, either plant or animal. Peat and coal are the most common organic sedimentary rocks. They are not found at Hidden Valley.

STRATIGRAPHY

Many geologists devote their entire lives to the study of the orderly sequence of strata or beds of sedimentary rock. They determine the relative age of the different beds, correlate them, and study the fossils contained in them. This part of geology is called *stratigraphy*, and those who study it are called *stratigraphers*. The study of fossils is called *paleontology*, and geologists who specialize in it are called *paleontologists*.

* The chemical formula for calcite is CaCO_3 , and when hydrochloric acid (HCl) is applied to it, a reaction occurs in which carbon dioxide (CO_2) and water (H_2O) are formed. The effervescence is due to the presence of bubbles of carbon dioxide in the water.

Stratigraphic Units

Stratigraphers have shown that sedimentary rocks occur in units or series of beds, called *formations*. Each formation has its own distinctive characteristics such as color, rock type, mineral content, bedding thickness, or fossil content, all of which help to identify the formation. For example, a formation may consist of gray limestone, or interbedded red sandstone and green shale. Each formation is named for a particular place where it is well exposed, called the *type locality*. For example, the Bloomsburg Formation is named for outcrops in the city of Bloomsburg in Columbia County, and the Tuscarora Formation is named for Tuscarora Mountain, in Perry and Juniata Counties.

To simplify matters, we can think of rock formations in terms of a layer cake (Figure 1). For example, a two-layer white cake represents two light-colored beds or strata comprising one formation. A four-layer cake, with the two top layers white and the two bottom layers chocolate, represents four beds consisting of a lower chocolate formation and an overlying white formation. If these were rock layers, we could apply the Law of Superposition and say that the white formation was deposited last, and therefore is younger than the chocolate formation.

It is often necessary for stratigraphers to illustrate the relationships of the rock formations that are present in an area. To do this, they draw stratigraphic sections, which show the vertical succession of rock formations, arranged with the oldest at the bottom and the youngest at the top. Figure 1 is a stratigraphic section through a layer cake, and

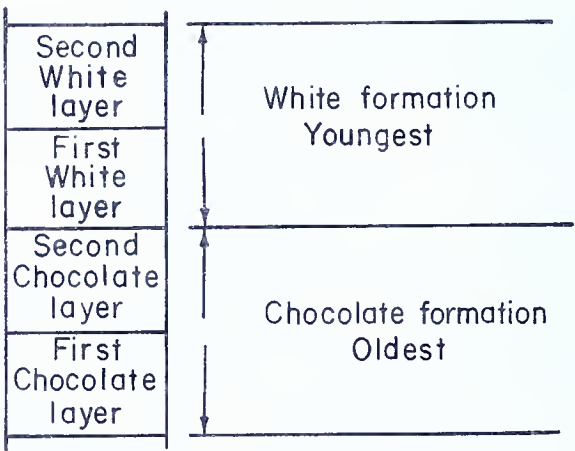


Figure 1. Stratigraphic section of a four-layer cake. In cakes, as in sedimentary rocks, the lower layers had to be put down before the higher layers.

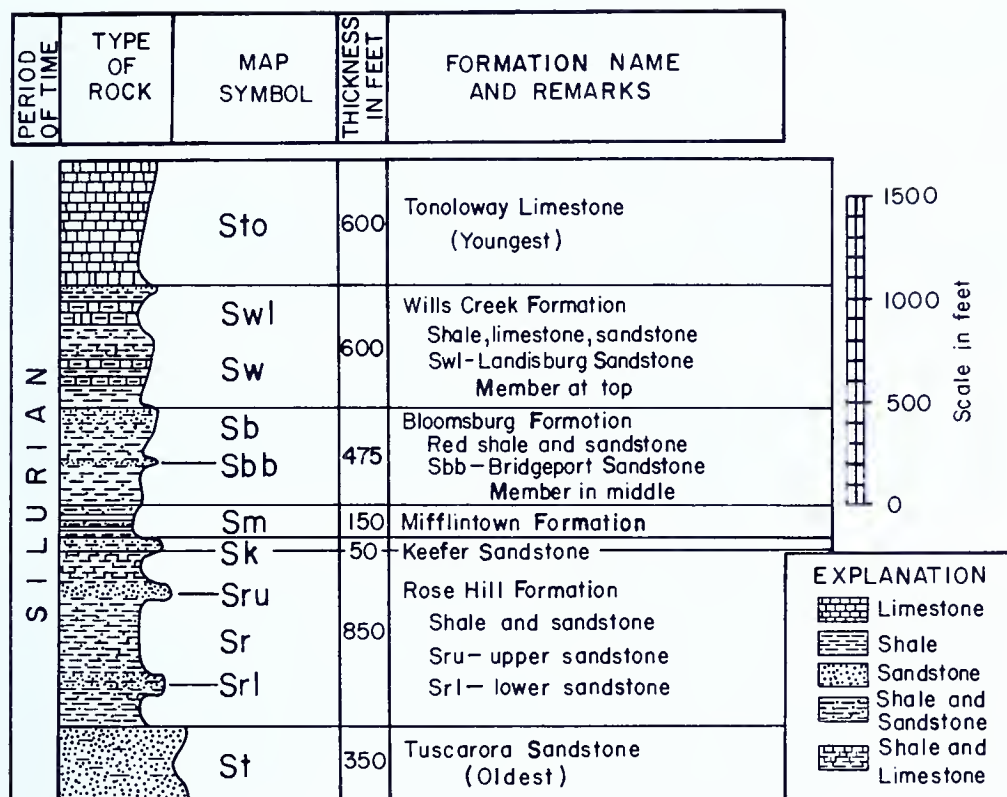


Figure 2. Stratigraphic section showing the rock formations which occur in the Hidden Valley area.

Figure 2 is a stratigraphic section of the rock formations in Hidden Valley. Note that on the left side of the stratigraphic section is a column showing the geologic period in which these formations were deposited. All of the rocks in camp were formed during the Silurian Period, and are about 400 million years old. The next column shows, by various patterns, the kind of rock found in each formation. Next to this are listed the abbreviations or map symbols which represent the various formations. Note that each abbreviation begins with the letter S. This stands for the Silurian Period in which these rocks were deposited. The thickness of each formation is given in the next column, and the right-hand column gives the names of the formations.

In some cases, groups of strata within formations can be identified in the field and traced on geologic maps. These units are called *members* of the formations, and may either be named in the same way as formations are, or simply referred to as "upper member" or "lower member".

GEOLOGIC MAPS

The best way for a geologist to illustrate the geology of an area is by preparing a *geologic map*. These are maps which show the distribution of the various rock formations, the geologic structure, and the locations of outcrops. Plate 2 is a geologic map of the Hidden Valley area* Note that the geologic map is drawn at the same scale, and covers the same area, as the topographic map (Plate 1). When used together, the two maps show the shape of the surface of the land and the rock formations which underlie the surface.

Each rock formation in the area is shown by a distinctive pattern and symbol on the geologic map. The explanation at the bottom of the map lists the formations which are present, and shows the pattern used to show their distribution.

The use of a particular map pattern on a geologic map does not mean that the entire area covered by that pattern is a large exposure of bedrock. What it does show is the rock formation which is present beneath the soil cover. These formations have been mapped by geologists, who, by combining information obtained from scattered outcrops, from the nature of the soils and the rock chips found in the soils, from records of rock found in wells and from studying aerial photographs, are able to outline the areas underlain by each formation.

GEOLOGY OF THE HIDDEN VALLEY AREA

The geologic map in this book (Plate 2) illustrates the geology of the camp area. The geologic map shows which parts of the camp are underlain by each different rock formation. In the appendix is a list of all the rock formations which are found here, with descriptions of some of the outcrops, and directions for finding them. The principal outcrops are numbered, and the numbers are shown on the topographic map. (Plate 1). By using the outcrop descriptions in the Appendix, and comparing the topographic map with the geologic map, a scout should be able to find all of the outcrops in camp. The locations of roads, streams and bridges are shown on Figure 10.

* This map is taken from part of the Geologic Map of the Loysville Quadrangle, Geologic Atlas 127, by John T. Miller, published by the Pennsylvania Geological Survey in 1959. Atlas 127 may be obtained from the Bureau of Publications, Dept. of Property & Supplies, P.O. Box 1365, Harrisburg, Pennsylvania 17125.

In the pages that follow, references are made to numbered outcrop localities where various geological principles are illustrated. As you read the text, you should refer to the Appendix for more information on these localities.

LOCATION AND GEOGRAPHY

The Hidden Valley Boy Scout Camp is located in the south-central part of Pennsylvania, in Tyrone Township, Perry County. The camp is 25 air miles west-northwest of Harrisburg, and one mile south of Loysville. This part of Pennsylvania is in the Appalachian Mountain Section of the Valley and Ridge Province, a long, winding chain of mountain ridges which extends all the way from Alabama to New England. The location map (Figure 10) shows the location of the camp relative to Loysville and Landisburg, and the index map of the geologic map (Plate 2) shows the location of the area within the state of Pennsylvania.

The region is about seven square miles in area. It is situated at the east end of Bowers Mountain, a long narrow ridge whose maximum elevation is about 2,100 feet, south-west of the camp. The ridge crest is at 900 feet elevation south of camp, and it ends at an elevation of about 500 feet in the valley east of camp. Bowers Mountain is bordered by a complex of low ridges and valleys on the north, and Schaeffers Valley on the south.

The main camp is located along Shermans Creek, which flows from distant mountainous areas west and northwest of camp, to the Susquehanna River, 17 miles to the east. Near camp, the sides of the stream valley vary from gently sloping terraces to steep valley slopes where the stream cuts into the northern slope of Bowers Mountain. It is for this area, where the valley of Shermans Creek invades the foothills of Bowers Mountain, that Hidden Valley was named.

Abundant forest land characterized by coniferous and deciduous trees surrounds the camp, providing plenty of cover for wild life and an opportunity for scouts to study the forest environment.

STRATIGRAPHY OF THE HIDDEN VALLEY AREA

The rocks of the Hidden Valley Camp area are all sedimentary rocks. They represent sediments 3,000 feet thick, which were deposited during a period of some 20 to 25-million years. Based on the geological time scale, these sediments were deposited during the Silurian Period between 375 and 400 million years ago.

The rocks of the camp area have been divided into seven units or formations. Figure 2 is an illustration of the stratigraphic section in camp, which can be compared to the layer cake section in Figure 1.

Most of the rocks in the Hidden Valley area were deposited in a marine or seawater environment. Figure 3 shows the area in eastern

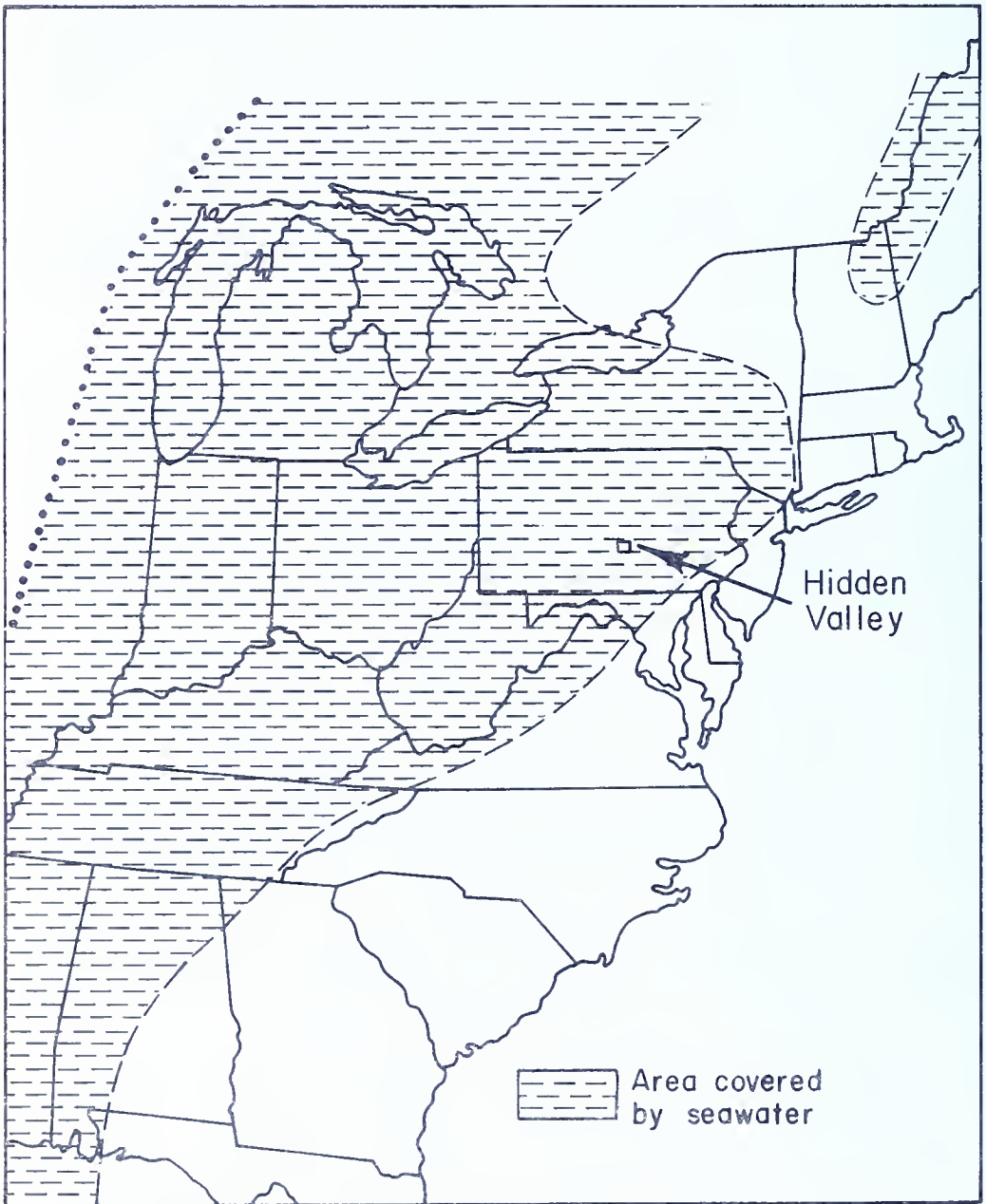


Figure 3. Map of the area covered by seawater in eastern North America during Silurian time. This kind of map, which shows the locations of ancient seas and land areas, is called a paleogeographic map.

North America which was covered by seas at one time or another during the Silurian Period. During much of this time, the seas were bordered by lowlands on the west with higher lands to the east.

The next few pages are devoted to a description of the rock formations which occur in the camp area, with references to the localities where they may be seen. The outcrop numbers at the beginning of each formation refer to the detailed descriptions in the Appendix. See Plate 1 for the locations of these outcrops.

Tuscarora Sandstone
(Outcrop locality #1)

Name and Description

The Tuscarora Sandstone is the oldest formation exposed in the area. It was named at Tuscarora Mountain in northern Perry County, where the formation is well exposed. It is a hard, white to light-gray rock composed of sand grains and a minor amount of small pebbles, cemented together by the mineral quartz, which is the chemical compound silica (SiO_2). The formation is approximately 400 feet thick. The thickness of a formation is measured perpendicular to the bedding and is the same as the height of the layers in the cake shown in Figure 1.

When a piece of rock is chipped from a Tuscarora boulder, the color of the freshly broken surface is whitish gray. However, the outer surface of the rock is a darker or medium gray. The darker outer color is due to weathering which results from chemical decomposition, caused by rain water, oxygen, and organic acids. Thus the color of the outer surface of boulder is referred to as the weathered color and often differs from the color of a fresh unweathered surface.

The Tuscarora Sandstone is found at or slightly below the tops or crests of most of the high ridges of Perry County. Similarly, it is found on the high part of Bowers Mountain west of camp at locality 1. Its occurrence high on the ridges is evidence that it is hard, durable, and resistant to weathering. Thus, one can infer that it is not worn down by erosion as rapidly as the rocks in the valleys on both sides of the mountain.

One fact which illustrates the power of erosion is that loose boulders of Tuscarora Sandstone are commonly found in valley bottoms. Usually the closest outcrop of Tuscarora Sandstone which can be found is high on a nearby ridge. One must explain how the boulders move from the original outcrop high on the ridge to the valley bottom. The answer

is that they are moved by stream erosion and the pull of gravity which causes rock slides and aids streams in slowly rolling boulders down hill, especially during time of flood.

Uses

The Tuscarora Sandstone is commonly referred to as "ganister rock", a commercial name for rock which is quarried and made into silica brick and used to line the inner walls of iron furnaces. It is also used as glass sand from which glass products are made, as building stone, and as ballast for railroad beds.

Rose Hill Formation

(Outcrop localities 2 through 15.)

Name and Thickness

The Rose Hill Formation is named for a locality on Rose Hill, Cumberland, Maryland and can be traced continuously along many ridges from Maryland to Perry County. In the Hidden Valley area the formation is about 850 feet thick, and underlies most of the camp area.

Relation to Topography

West of camp, the whitish Tuscarora Sandstone underlies the crest of Bowers Mountain and the Rose Hill Formation makes two series of spurs or small ridges on the northwest side of the mountain and a smaller terrace-like ridge on the southeast side of the mountain. On the geologic map (Plate 2) it can be seen that from west to east, the Rose Hill ridges join and form a single ridge which becomes lower and lower until the ridge ceases.

Description

The Rose Hill Formation consists of both sandstone and shale beds of several colors. There are two zones of sandstone, one in the upper half and the other in the lower half of the formation. The remainder of the formation is mainly shale interbedded with a few thin sandstone beds. The beds vary in thickness from a maximum of 2 to 3 feet in the sandstone to a fraction of an inch thick in the shales.

The Rose Hill sandstones can be recognized easily owing to their purple or grayish-red color and massive outcrops as seen in the camp area at locality 7. The color in these rocks is due to hematite, a dark-red iron mineral which occurs as a coating on the sand grains and as a cementing material between the grains.

The shales of the Rose Hill Formation are not often well exposed. However, some shale can be seen associated with the sandstones at most of the Rose Hill localities described in the appendix. The shales are easily recognized by their pale-yellow and olive-green color associated with the grayish-red sandstones.

The grayish red of the sandstones is only slightly altered to a darker color by weathering. However the shales, when fresh, are various shades of olive gray, pink, and medium gray, and commonly weather to pale yellow and yellowish brown. The weathered shale can be seen along stream banks, or in debris at the base of fallen trees, or piled at the entrance of woodchuck holes. The sandstone is more resistant to weathering than the shale, and covers the slopes of small ridges where erosion is slowly moving plate-like fragments and smaller pieces down into the valleys.

Historical Clues

One feature of sedimentary rocks which is well shown by the Rose Hill sandstones is *cross-lamination* or *cross-bedding*. These are thin beds or laminations which inclined at an angle of 30° to 35° to the main bedding, as shown in Figure 4. Cross bedding is formed by currents which carry and deposit sand. The change in the amount and direction of the inclination from one cross-bed set to another shows that there were changes in the direction of flow in the stream from time to time.

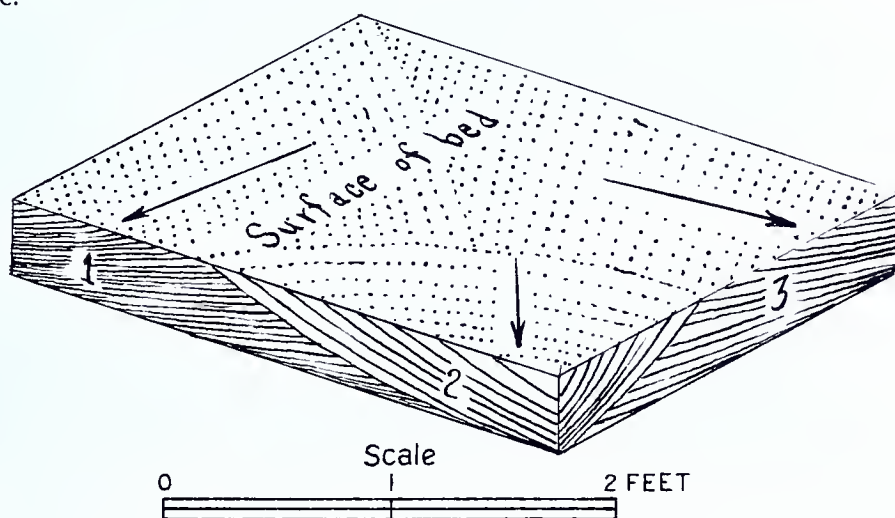


Figure 4. Block diagram of a block of cross-bedded sandstone. Three sets of cross-bedding are shown, as they appear on the top and sides of a bed. The arrows on the top of the block indicate the direction of the currents which formed each set of cross-beds.

The direction of the current which causes cross-lamination can be determined, and is the direction in which the cross-laminae dip or tilt on the side of the bed. Good example of cross-lamination can be seen at Station 5 and 9, and also at most of the other outcrops of the grayish-red sandstones.

Some of the bedding surfaces in the Rose Hill sandstones are very irregular, rather than being smooth like the cover of a book. Some of these irregularities, such as *ripple marks*, are the result of the action of the current which originally deposited the sand. Many of them, however, were formed by something which disturbed the sediment after it was deposited, such as burrowing worms or crustaceans. Ripple marks in rock, which are illustrated in Figure 5, are the same as the ripple marks which you can see on the bottom of many present-day streams and on beaches. Here is another case where we can use the present as a key to the past. These ripple marks tell us that the water which deposited this sand must have been fairly shallow. In some cases, they also show the direction in which the currents were flowing.

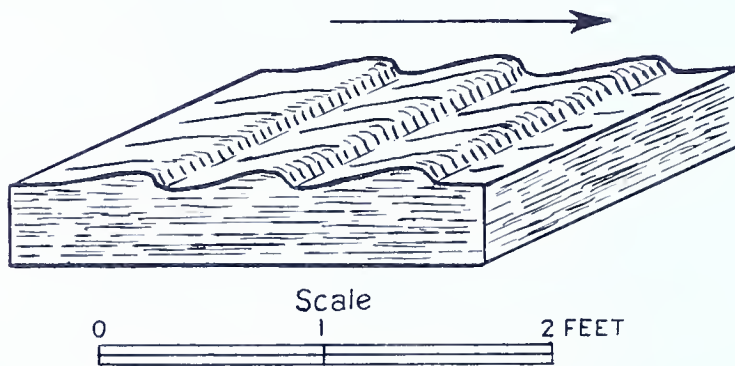


Figure 5. Block diagram showing ripple marks on sand. Ripple marks look the same whether they are found at the bottom of a present-day stream or in an ancient sandstone bed. We can tell which direction the current was flowing in by looking for the steeper side of the ripple, and examining the laminations of the sand within the ripple.

Fossils

In some places fossils are abundant in the Rose Hill Formation. The remains of various types of sea shells can be found in the shales and in the thin beds of sandstone which are interbedded with the shales.

History

The Rose Hill Formation was deposited during a time characterized by seas of moderate to shallow depth. The thick sandstones represent times when the sea was probably shallower than during the periods of shale deposition. The iron minerals in the sandstones imply that during the time of sandstone deposition the adjacent coast line was low, swampy, and not disturbed by mountain-making.

Uses

Locally, the Rose Hill shales are used for road fill. Some large borrow pits are operated from time to time in Perry County, although there are none within the camp area.

In the nineteenth century iron ore was mined from one or two horizons in the Rose Hill Formation along Tuscarora Mountain several miles north of camp, but these deposits can no longer be profitably mined.

Keefer Formation

(Outcrop localities 16 through 23.)

Name and Thickness

The Keefer Formation was named for exposures on Keefer Mountain in southern Franklin County, Pennsylvania, and can be traced into Perry County from there. It is about 40 or 50 feet thick, and can be seen in several good exposures along the streams and road-cuts in this area.

Relation to Topography

Topographically, the Keefer Formation usually forms a small ridge, which stands above the valleys or depressions which develop over the shaly formations which lie both above and below the Keefer. The Keefer Sandstone is present on the northeast side of Shermans Creek at Station 19, and can be traced northeast up the stream bank, under Rotary Lodge, and on up the hill to an exposure in a small borrow pit where it has been dug out for rock fill. The Keefer Sandstone, and the overlying Mifflintown Formation can be followed southwest across camp to Stations 20 and 25, and past the south end of the swimming pool. One of the best Keefer outcrops is in a small stream valley at Station 22.

Description

The Keefer sandstone is dark gray, medium to brownish and whitish gray on fresh surfaces, and light gray on weathered surfaces. The grain size varies from sand to small pebbles. There are three sandstone horizons each several feet thick interbedded with dark-gray shale and very fine-grained sandstone.

Some iron minerals are found in the lower and upper parts of the sandstone. The one most commonly found is pyrite, often called "fool's gold" due to its golden yellow color. It is an attractive collectors item, but is not of commercial value except under special circumstances.

History

The Keefer Formation contains marine fossils, which indicates that the sand was deposited in the salt-water of the ocean. The sand was probably deposited either along the shore-line or else very close to shore. Ripple marks, cross-bedding and fossils can be seen in the Keefer sandstone in some of the outcrops.

Uses

The Keefer Formation has no commercial value at the present time, except for occasional use as rock fill for roads or foundations.

Mifflintown Formation

(Outcrop localities 24 through 28.)

Name and Thickness

The Mifflintown Formation was named for exposures near Mifflintown, which is on the Juniata River in Juniata County. The Mifflintown Formation is about 150 feet thick.

Description

The Mifflintown Formation consists of interbedded limestone and shale. The limestone is dark gray on a fresh surface, but usually turns dark brown after being exposed to the weather. The shale is gray, thin-bedded, and usually calcareous or "limy".

History

The limestone and shale of the Mifflintown Formation is also a marine deposit, and probably formed offshore from the beaches where

the Keefer sand was being washed by the waves. The very fine particle size of the shale indicates that it originated as mud, deposited in deep, still water.

Bloomsburg Formation
(Outcrop localities 27 through 35.)

Name and Thickness

This formation was named for exposures in Bloomsburg, Pennsylvania, where it was first described. In the Hidden Valley area it is about 475 feet thick.

Relation to Topography

The Bloomsburg Formation in Perry County outcrops along the base of all the high ridges such as Bowers Mountain. In the foothills, it forms the upslope limit of agricultural and pasture land and in many places is covered with forest growth.

Description

The red color is the most characteristic feature of the Bloomsburg Formation. It is a dark brownish red, and can be seen exposed in a cliff face by looking north-west along Shermans Creek from the east vehicle bridge.

The Bloomsburg Formation rocks vary from shale to sandstone, and are all red except for a light-gray sandstone and conglomerate in the middle of it. This sandstone, which is called the Bridgeport Member of the Bloomsburg Formation, is 5 to 15 feet thick. The Bloomsburg red beds retain a red color even when they have been deeply weathered, and give a red color to the soil above them.

In the Loysville area, a few small fossils have been found in the Bloomsburg red beds, some being small fragments of primitive fish. However, there are no known fossil localities in the Bloomsburg beds of the Hidden Valley area.

History

The Bloomsburg Formation is thought to have been deposited by rivers and streams in the shallow, brackish (slightly salty) marine water of a coastal area. The fish remains found are from fish which probably lived in nearby fresh or brackish water and were transported to the Hidden Valley area by streams and currents flowing from the east and southeast.

Bloomsburg-type sediments are characteristic of river deltas similar to the Mississippi River delta now being deposited along the Gulf

Coast. Thus, the seas in which the Rose Hill-Keefer-Mifflintown marine formations were deposited must have been made shallow by uplifting of the land or lowering of the sea until the Hidden Valley area became intermittently dry land, very close to sea-level, along a vast coast line that stretched from New York to Maryland and probably farther south.

Uses

The Bloomsburg is used for road fill, and although cultivated to some extent, is best for pasture land. It has no other local commercial value, here, although it is quarried near Beavertown in Snyder County, and used for making bricks and ceramic tile.

Wills Creek Formation

(Outcrop locality 36.)

Name and Thickness

The Wills Creek Formation was named for a creek near Cumberland, Maryland, and can be traced from there to the Perry County area. At Hidden Valley, it is about 600 feet thick.

Relation to Topography

The formation outcrops in, and underlies, the major valleys and lowlands of Perry County. Near Hidden Valley it occurs in the broad valleys north and south of Bowers Mountain. It is easily recognized as two low, distinct, parallel ridges, each ridge representing half of the formation.

The Wills Creek Formation is commonly called a shale, but near Hidden Valley consists of interbedded shale, limestone, and minor sandstone. The Landisburg Sandstone member, 10 to 20 feet thick, is present at the top of the formation and underlies several small ridges in the cultivated area north and east of the camp area.

There are several rock colors present. The lower half of the formation is interbedded red and pale-green shale and very fine-grained sandstone which can be seen at locality 36. The upper half of the formation is dominantly medium gray and variable from shale to shaly limestone, the main exception being the red Landisburg Sandstone Member at the top.

The color of the rocks does not change much with weathering, except for the impure, gray limestones and pale-green shales which weather to a pale yellowish brown or yellowish gray.

Fossils

There are many fossils present in the Wills Creek Formation, but only two or three different types. A small, shelled animal with a pair of shells like a clam makes up 90 percent of the fossils. The shells are bean-shaped and found in various sizes ranging from the size of a lima bean to the size of a pinhead. These animals are called ostracods.

Other fossils present are small sea shells (brachiopods) about one-half inch long, and snail shells one-fourth to one-half inch long.

In the Landisburg Sandstone Member, at the top of the formation, fragments of primitive fish are found. Lack of good exposures near camp prevents good fossil collecting.

History

During deposition of the Wills Creek sediments, the Hidden Valley area was very close to sea level and while the lower half of the formation was being deposited the land surface probably oscillated up and down slightly above and below sea level. During deposition of the limestone in the upper half of the formation, the area was mostly beneath sea level.

While Wills Creek sediments were accumulating in the Hidden Valley area, thick salt deposits were being deposited in inland sea basins over much of western Pennsylvania, south-central and western New York, and a greater area to the west. Perry County was marginal to the salt basins, and was characterized by less salty, shallow seas.

Uses

The Wills Creek Formation underlies much of the fertile farm land in Perry County thus its chief use is agricultural. The banded yellowish and reddish weathered color of the shales is easily noted in the soil of many fields.

Tonoloway Formation
(Outcrop locality 37.)

Name and Thickness

The Tonoloway Formation was named for a ridge in Maryland. The formation can be traced from Maryland to the Hidden Valley area where it is about 600 feet thick.

Relation to Topography

The Tonoloway Formation, similar to the Wills Creek Formation, underlies the major valleys or cultivated areas.

Description

The formation is mostly medium-gray, impure limestone and limy shale. Thus it resembles the rocks of the upper Wills Creek. However, there is more limestone in the Tonoloway than in the Wills Creek Formation. The limestone in the Tonoloway Formation weathers readily, and as a result outcrops are few compared to other formations.

Fossils

Fossils present in the Tonoloway include ostracods, similar to those present in the Wills Creek Formation, plus other small marine shells.

History

The marine fossils and other features in the Tonoloway indicate that the sediments were deposited in a shallow sea. West and north of Perry County, the period of salt deposition continued through Tonoloway time.

Uses

The Tonoloway Limestone has been quarried in many places in Perry County. The material has been used extensively for crushed rock and in the past, many farmers have burned the limestone to obtain lime which they used as a soil conditioner.

GEOLOGIC HISTORY

To the trained observer, studying the layers of ancient rock is like reading headlines from the past. The mineral grains which now make up sedimentary rock formations were once sediment, which accumulated, under water, in some kind of natural environment. The sedimentary environment always leaves its imprint upon the sediments deposited there, and on the animals which live there. By carefully observing the details in the rock strata, we can reconstruct the history of the area in the geologic past. Geologists who specialize in this are called *sedimentologists*, and their goal is to interpret ancient environments in terms of water depth, salinity, and distance from the shore, and to tell the direction of flow of ancient river and ocean current systems.

At the time of the deposition of the Tuscarora Formation, this area was apparently part of a broad coastal plain, across which streams flowed northwestward towards a broad, shallow inland sea which occupied parts of western Pennsylvania, Ohio, and the surrounding area. By the time the Rose Hill shales were deposited, the shore of this ancient sea had migrated eastward, until all of Perry County was under water. The two iron sandstone members in the Rose Hill Formation, and the Keefer Sandstone are near-shore deposits. They show that the shore line was fluctuating and migrating, and did not remain forever in the same place. During the deposition of the Mifflintown Formation, a normal marine environment returned, as indicated by the presence of limestone with fossils of seashells and other sea animals.

Early during deposition of the Bloomsburg and Wills Creek Formations, the sea became very shallow. During deposition of the Tonoloway, the water gradually deepened and limestone muds were deposited. To the northwest in New York and western Pennsylvania, salt was being deposited in an inland, landlocked sea as the Wills Creek and Tonoloway were deposited here.

The rocks in nearby areas which are younger than the Tonoloway limestone indicate that the Hidden Valley area was alternately exposed and covered by seawater several times after deposition of the Tonoloway lime muds, during a period of millions of years. Finally about 200 million years ago, a period of mountain making occurred which exposed the Hidden Valley area as dry land and folded the sediments into a series of valleys and ridges which trend northeast. It is likely that the area has remained as dry land from the period of mountain making until the present day.

STRUCTURAL GEOLOGY

We have seen that sedimentary rocks consist of layers, beds, or strata. When the sediments are first deposited, these layers are nearly horizontal, but during periods of mountain-making, the beds often become wrinkled or folded, as shown in Figure 6, or broken and faulted, as shown in Figure 7. Where the rocks have been folded, the "up-folds" or structural ridges are called *anticlines*, and the "down-folds" or structural troughs are called *synclines*.

When layers or beds of rocks are deformed by folding and faulting, the process is called deformation. The study of the deformation of rocks is called *structural geology*, and the folds and faults are called geologic structures. In some areas, rocks have not been deformed very much by mountain-building, and a flat layer-cake arrangement is maintained.

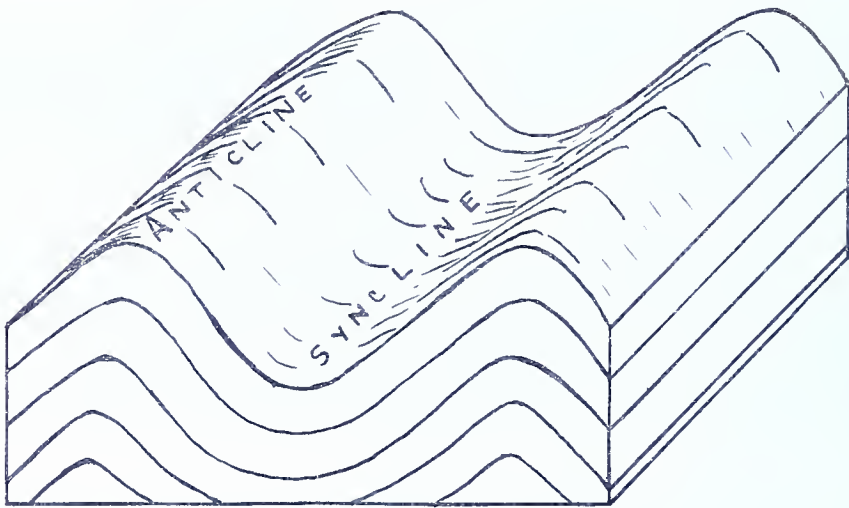


Figure 6. Block diagram showing folded beds of rock.

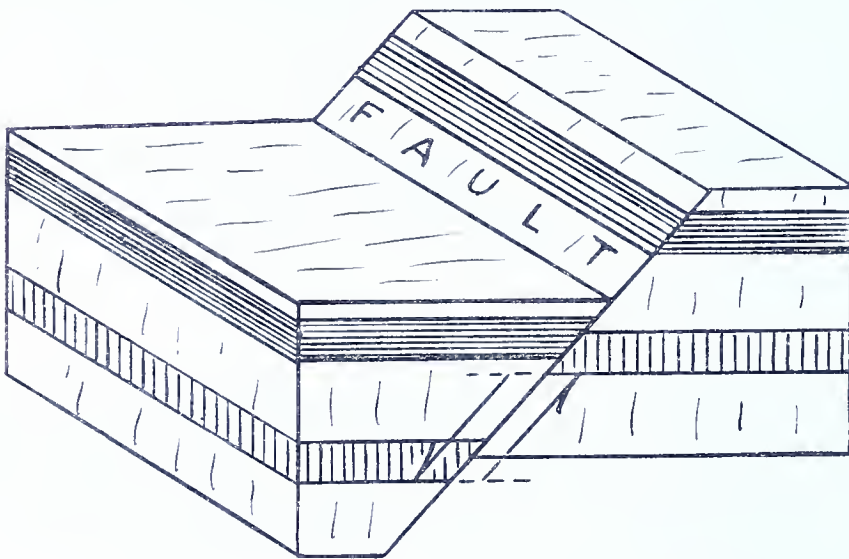


Figure 7. Block diagram showing faulted beds of rock, with arrows showing the relative movement of the two blocks. This type of movement is called a normal fault. If the left-hand block had moved upwards, the fault would be called a reverse fault.

This is true on the Allegheny Plateau of western Pennsylvania, but in the central part of the state the rocks were folded and faulted during a long period of mountain-building which occurred about 200 to 250 million years ago. At that time, the whole Appalachian Mountain chain (including Hidden Valley) was slowly uplifted by forces acting in the earth's crust. Since that time erosion has been gradually wearing away the mountains. Several gentle uplifts have occurred since that time, and in all a total of five vertical miles of rock has been removed by erosion. In the future, erosion will continue to wear down the mountains, but the process is a slow one, and uplifting will probably be repeated, so that we will always have land above sea level.

How Geologic Structures Are Found

Before describing the structure of Bowers Mountain, it is necessary to know the sort of observations made by geologists to determine the type of structural features present in an area.

Where beds of rock are not tilted, it is easy to describe their structure by saying they are horizontal. However, if rocks are folded at all, the rocks are inclined and the tilt must be described in definite terms. To describe the tilt, geologists use two terms: *strike*, and *dip*: Figure 8 shows an outcrop of a bed which is tilted.

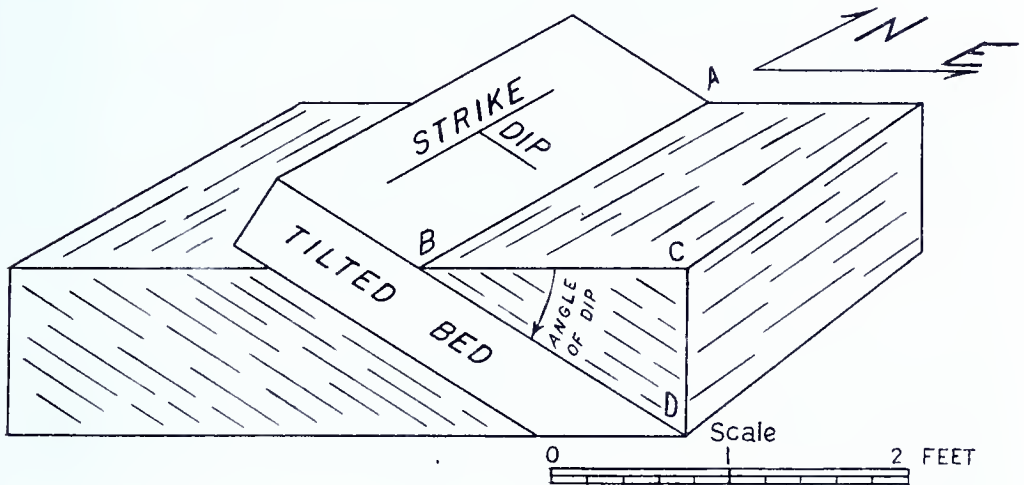


Figure 8. Block diagram illustrating strike and dip. In this example, the direction of strike is due north, and the dip is about 30° to the east.

The top of the block shown in Figure 8 represents a horizontal or level place on the surface of the earth, with an outcropping rock layer. A line can be drawn along the intersection of the top of the inclined rock layer with the surface of the ground, which is the line from A to B on the sketch. The direction of this horizontal line is called the *strike* of the bed, which in this case is due north. Outcrops such as this, on level ground, are seldom seen in the field, and are not really necessary to measure the strike of a bed. All that is needed is an outcrop on which a horizontal line can be drawn. The direction of this line is the strike of the bed.

The inclination, or *dip* of a bed must be measured at right-angles to the strike, and in Figure 8 it is the angle between line BC and line BD. When geologists are measuring the strike and dip of beds, they use an instrument called a *Brunton Compass*. A Brunton Compass is an ordinary compass which is equipped with a bubble level, for finding the strike, and a clinometer for measuring the angle of dip.

The directions of strike and dip on the figure are represented by the symbol  on the surface of the bed. The long line shows the direction of strike and the short line shows the direction of dip. This is the symbol used on geologic maps to indicate the strike and dip, which may be referred to as the *attitude* of the beds.

Geologic Structure of Hidden Valley

The rocks of Hidden Valley have been folded and also locally faulted. The geologic structure is illustrated in a block diagram in Figure 9. In this figure, two sections of the crust of the earth containing the Hidden Valley area are shown as they would appear if seen from a point above Bowers Mountain, about two miles southwest of camp. The geologic structure beneath the surface of the ground is shown on the edges of the two blocks, which are known as *cross-sections*. The locations of the cross sections, labelled AA' and BB', are shown by lines on both the topographic and geologic maps (Plates 1 and 2).

Note that Bowers Mountain is an anticline and the valleys north and south of the mountain are synclines. The bottom or trough-line of the syncline south of the mountain occurs approximately along Laurel Run on section AA'.

The ridges are underlain by the resistant sandstones such as the Tuscarora and parts of the Rose Hill Formations, and the valleys are underlain by less resistant, more easily eroded shale and limestone such as

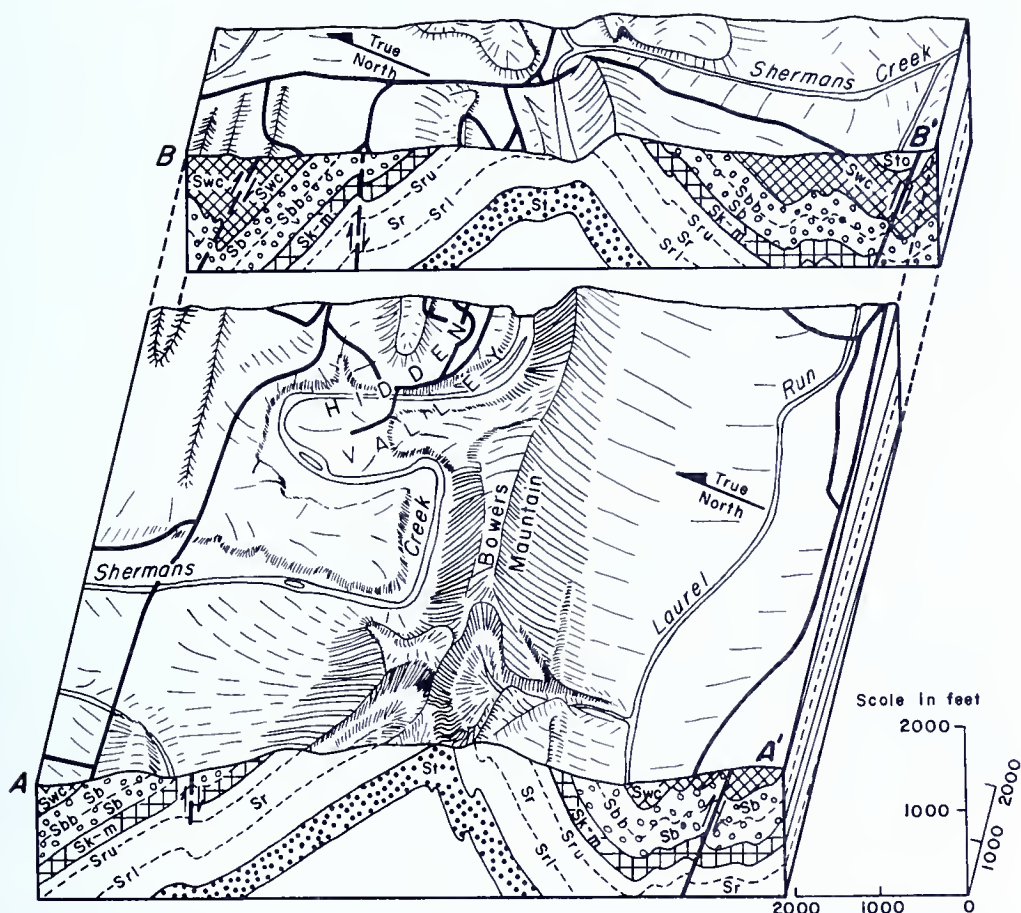


Figure 9. Block diagram of the Hidden Valley area, illustrating the relationship between rock formations, geologic structures, and topography. The locations of cross-sections AA' and BB', are shown by lines on the topographic map (Plate 1) and on the geologic map (Plate 2). View is from the west.

the Wills Creek and Tonoloway Formation. On the geologic map (Plate 2) the pattern of the rocks shows that one can walk around the east end of Bowers Mountain, staying at all times on the rocks of the Rose Hill Formation. In doing so, the direction of the dip changes from 40 degrees northwest on the north side of the mountain, to a gentle northeast dip at the end of the mountain, to 70 degrees southeast on the south side of the mountain. The change in dip from the north to the south side of the mountain is evidence which shows that Bowers Mountain is an anticline.

Note that in section AA', the top of the Tuscarora Formation is present at the earth's surface. However, at section BB', to the northeast, the top of the same formation is almost 500 feet below the present surface of the earth. Thus the folded rocks plunge beneath the earth's surface in a northeasterly direction. For the same reason, Bowers Mountain plunges from a high ridge southwest of camp to a very small ridge northeast of camp where the Tuscarora Formation is not present at the surface. Thus, one might call the northeast end of the mountain the point or nose of an anticline in the Tuscarora and Rose Hill Formations.

FOR MORE INFORMATION

Geology: Merit Badge Series, edited by Frank Gouin and Dr. Chalmer L. Cooper, 79 pages, published by the Boy Scouts of America. A very readable and well illustrated booklet on the earth and its rocks, minerals, and fossils. A list of the requirements for the Geology Merit Badge is included.

TOPOGRAPHIC MAPS

Plate 1 is taken from the topographic map of Landisburg Quadrangle. Topographic maps for every part of the state, and most of the other states, are available from the U. S. Geological Survey in Washington, D. C. To find out the names of the various quadrangles and the area each covers, write to the Pennsylvania Geological Survey for the current Topographic Index Map of Pennsylvania (free).

STATE PUBLICATIONS

The Pennsylvania Geological Survey has published a number of interesting pamphlets, books, and maps illustrating the geology of the state. The Educational Series pamphlets, which are distributed free, can be obtained by writing to the Pennsylvania Geological Survey, Main Capitol Annex, Harrisburg 17120. Other state publications, for which a charge is made, are sold through the Dept. of Property & Supplies, Division of Documents, 10th and Market Streets, Harrisburg 17125. Be sure to include the sales tax.

Educational Series

- ES 1 Common rocks and minerals of Pennsylvania, by D. M. Lapham and A. R. Geyer. 1962. 22 p., 25 figs.
- ES 2 Common fossils of Pennsylvania, by D. M. Hoskins. 1962. 20 p., 6 figs., 3 pl.
- ES 3 Ground water, by A. E. Becher. 1971. 44 p., 29 figs.
- ES 4 Pennsylvania's geology summarized, by Bradford Willard. 1962. 17 p., 3 figs., 1 pl.
- ES 5 Geology and the Gettysburg campaign, by Andrew Brown. 1962. 15 p., 2 figs.
- ES 6 Pennsylvania and the Ice Age, by V. C. Shepps. 1962. 33 p., 19 figs.
- ES 7 Coal in Pennsylvania, by W. E. Edmunds and E. F. Koppe. 1968. 28 p., 12 figs.
- ES 8 Oil and gas in Pennsylvania, by W. S. Lytle and W. R. Wagner. 1968. 28 p., 16 figs.

Atlas Series

A 127 Loysville Quadrangle, by J. T. Miller, 1961. 47 pages, 8 figures, and 2 plates, including a geologic map and cross section sheet. Scale 1:24,000 or one inch equals 2,000 feet. \$8.85 plus tax.

Geologic Atlas Reports are also available for several other areas of the state at different prices.

General Geology Reports

G 33 Mineral collecting in Pennsylvania, by D. M. Lapham and A. R. Geyer. 3rd Edition, 1969, 164 pages. Describes 61 mineral collecting localities.

\$0.50 plus tax.

G 40 Fossil collecting in Pennsylvania, by D. M. Hoskins, 1964. 126 pages, 109 figures. Describes the major fossil groups, and lists fossil collecting localities for 63 of the 67 Pennsylvania counties.

\$0.50 plus tax.

APPENDIX—DESCRIPTION OF OUTCROP LOCALITIES

INTRODUCTION

Bedrock is exposed as ledges both large and small along stream valleys and on the mountain slopes in the camp area. On the following pages, many of the major outcrops in the camp area are briefly described so that scouts will be able to find the best exposures of the various rock formations.

In referring to station localities, the distances are given in thousands of feet. A boy scout who wishes to visit the localities can locate them by measuring his pace, and then determining the distance by counting paces while walking.

The localities for the rock formations are numbered consecutively, starting with the oldest formation present here, the Tuscarora sandstone. After each locality number is an index number, such as (A-1) or (C-4). These numbers refer to the letters and numbers in the margins of the topographic map and geologic map, and have been included to help you to quickly find each station.

A map of the camp area (Figure 10) showing the place names used in the Appendix is included.

LOCALITY DESCRIPTIONS

Tuscarora Sandstone

Station 1 (C-1)

This locality is easily recognized by the presence of large boulders of whitish-gray to light-gray Tuscarora Sandstone along the mountain top. The boulders have been moved only slightly by erosion and thus represent bedrock.

The attitude of the beds is not apparent, but the dip is gentle toward the northeast, this being the crest of the Bowers Mountain anticline. The beds can be traced a quarter of a mile northeast along a trend parallel to and about 140 feet south of the edge of a pine forest beyond which the Rose Hill covers the Tuscarora Formation (see geologic map, Plate 2).

This is the only known occurrence of the Tuscarora Formation in the Scout Camp area.

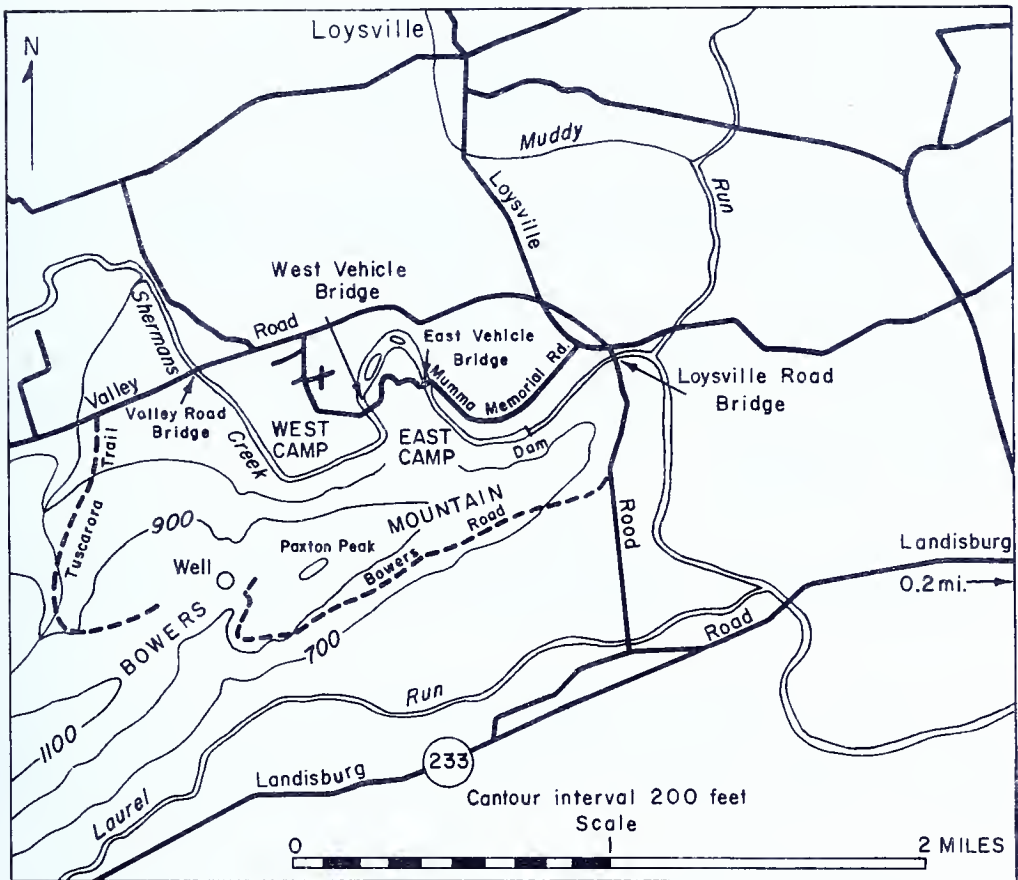


Figure 10. Location Map of the Hidden Valley area showing the location of place names used in the Appendix.

Rose Hill Formation

Station 2 (B-4)

This station is located at a small wooden shanty on the west side of Muddy Run, on the south side of a dirt road which runs east from the Loysville Road.

The outcrop consists of purplish or grayish red beds of the massive upper sandstone in the Rose Hill Formation. The average strike is north-23-degrees-west and dip is 19 degrees northeast. The outcrop at this station can be traced west to stations 7, 8, 9, and 10.

Station 3 (B-3)

This station is the rock exposed in the road bank along the east side of the Loysville Road, half-way between the East Entrance to camp and the Loysville Road Bridge.

The outcrop consists of interbedded thin to medium thick beds of green-gray to olive-gray shale and fine-grained sandstone, which occur between the Rose Hill upper and lower sandstone. The average strike is north-80-degrees-west and the dip is 22 degrees northeast. The sandstone beds are broken into rectangular blocks by nearly vertical cracks or fractures which are called joints. There are two main directions of jointing, the strikes of which average north-45-degrees-west and north-42-degrees-east.

Some of the sandstone beds contain small marine fossils. The centers of many of the sandstone blocks are weathered and somewhat crumbly when broken but are difficult to break due to a thin hard shell of red iron minerals.

Station 4 (B-3)

On the south side of Shermans Creek, west of the Loysville road is a prominent ridge which slopes steeply down to the road.

The ridge is underlain mainly by the upper sandstone of the Rose Hill Formation. Evidence of this can be seen in the prominent ledge present behind the house on the west side of the road and also in the grayish-red sandstone debris present along the road south of the house. The beds strike northeast along the ridge and dip steeply southeast.

One of the main reasons for the presence of the ridge is that the Rose Hill upper sandstone is very resistant to erosion, and is not eroded as rapidly as the rocks in the valleys north and south of the ridge.

Station 5 (B-3)

This station is located south of the Mumma Memorial Road at the north end of the dam in Shermans Creek, approximately 1800 feet west of the Loysville Road.

Below the dam on the north stream bank is an outcrop of the grayish-red Rose Hill lower sandstone. The beds are medium- to thick-bedded and the bedding surfaces are irregular. The strike is north-20-degrees-west and the dip only 15 degrees northeast, which means that this is nearly the crest or top of the anticline. Contrast the attitude (strike and dip) at station 3 and 4 with this locality.

At the breast on the north end of the dam is a loose block of grayish red sandstone. Many small white fossil-shell fragments can be seen on the bedding surface.

Station 6 (B-3)

This station is located on the north side of the Mumma Memorial Road about 850 feet southeast of the East Vehicle Bridge which crosses Shermans Creek.

The outcrop at this station consists of a five to ten-foot ledge of grayish red Rose Hill lower sandstone. Note that the beds which show cross-laminations (see Figure 4) contain coarse sand grains and are characterized by small, white shell fragments. The water currents which deposited these coarsely-grained sediments must have been stronger than the currents which deposited the very fine-grained or mud-like sediments present at many stations.

The dip at this station is gentle northeast, and if these beds were completely exposed and could be traced, they would probably connect with the beds which crop out in the north stream bank at the dam. West of this station these beds cross Shermans Creek south of the East Vehicle Bridge.

Station 7 (B-3)

This station is located at the east end of the East Vehicle Bridge, on the north side of the road.

Along the eastern bank, north of the bridge, is a nearly complete exposure of the grayish-red Rose Hill upper sandstone. Within 170 feet northwest from the bridge one can walk past the inclined strata from the bottom to the top of the upper sandstone. Close inspection of these beds reveals many interesting things such as irregular bedding surfaces, casts of worm tubes lying on the bedding, cross-lamination (Figure 4), variation in grain size from bed to bed and possibly a few shell fragments. The total thickness of the several sandstone horizons is 100 feet.

Between 170 feet and 375 feet northwest from the bridge is a poorly exposed section of the uppermost Rose Hill which consists mostly of olive gray shale, very fine-grained sandstone and weathered calcareous or limy beds.

Northward from the bridge the strike of the beds changes from north-73-degrees-east to north-62-degrees-east and the dip changes from 37 to 45 degrees northwest.

These beds can be traced along strike, eastward, to the prominent ridge north of the Mumma Memorial Road and westward to stations 8 and 9.

About 1000 feet north of the bridge, a bluff of Bloomsburg red beds can be seen on the north and east side of a bend in Shermans Creek.

Station 8 (B-2)

This station is well known to the Scouts as Eagle Rock. It is located on the east bank of Shermans Creek, near the West Bridge. At this place, the Rose Hill upper sandstone forms a small cliff and steep valley walls 30 to 40 feet high. The rock type is the same as at other stations on this horizon. Note that fragments of the darkest colored rock are heavier than similar sized pieces of rock from other formations in the Scout Camp area. This is due to a significant, though not commercial content of iron-mineral compounds.

The strike of the beds is about north-60-degrees-east and the dip is 35 to 40 degrees northwest.

Refer to the last paragraph of the description of station 9 for an interesting fact about stream erosion.

Station 9 (B-2)

This station is on the west side of Shermans Creek, across the creek from Eagle Rock. This is one of the stops on the camp's, "Forest and Waters Trail."

The rock which crops out here as a ledge is the upper sandstone member of the Rose Hill Formation. The strike of the beds is north-60-degrees-east and the average dip is 38 degrees northwest. A strike and dip symbol (Figure 8) is drawn in aluminum paint on the underside of a bed at the east end of the outcrop. The arrow points in the direction of the dip.

The main beds vary from thick to thin-bedded and are characterized by thin cross laminae (Figure 4). The bedding surfaces are characterized by ripple marks (Figure 5), shale chips, animal trails (?) and tube-like casts of small worms which probably lived in the marine or brackish water during the time of deposition.

Note that there are many cracks or fractures nearly perpendicular to the bedding. The fractures are called *joints* and were caused by forces exerted on the rocks during the period of mountain making, when the rocks were folded. A white or grayish white mineral can be seen on some of the joint surfaces. This mineral is quartz, a very hard mineral which although brittle and breakable, is harder than steel and cannot be

scratched with a nail or knife-blade. This is the mineral which is used to make glass, refractory bricks for lining iron furnaces, abrasives such as some types of sandpaper and many other commercial products. However, the quartz found here is not pure enough to be commercially valuable. Most of the sand grains in the Rose Hill sandstones are also composed of quartz. Commercial quartz sands must be clear and white rather than dirty such as the sandstones of the Rose Hill Formation.

Note that Eagle Rock is northeast along strike from the ledge at this station. The two ledges were at one time continuous across the stream valley, and still are continuous beneath the stream. This shows that Shermans Creek has cut a notch in the inclined sandstone beds. Due to resistance of the hard sandstone to erosion, Eagle Rock and station 9 still stand as prominent ledges on the valley slopes where erosion is less rapid than in the stream valley.

Station 10 (B-2)

Two thousand feet west of the west entrance to Camp is a bridge across Shermans Creek, along the Valley Road. This station is located on the east bank of Shermans Creek, about 2000 feet southeast along the creek from this bridge.

The outcrop consists of the upper sandstone member of the Rose Hill and some of the shales and fine-grained, olive-gray sandstone beds which overlie it. The beds strike north-65 to 70-degrees-east and dip 50 to 55 degrees northwest. The rock ledge at this station is a westward continuation of the ledges at stations 8 and 9.

A few shaly and sandy beds contain fairly abundant small marine fossils at this locality. The best fossil hunting is in the beds which occur along the stream a few feet north from the massive sandstone ledges.

Station 11 (C-2)

This station is located near Bowers Road, an abandoned farm road, which can be followed west along the south side of Bowers Mountain. The road entrance is at a barn 2300 feet south of the Loysville Road Bridge which spans Shermans Creek. The farm road can be followed west for 7000 feet (1-1/3 miles). Then it turns northwest and northeast around the end of a ridge cut off by a small north-south valley. Station 11 is located 400 to 500 feet northeast of this turn in the road, at the crest of the ridge.

The outcrop ledge which forms the north crest of the ridge consists of massive beds of medium-gray to greenish-gray sandstone. These beds represent the lower portion of the Rose Hill lower-sandstone. The strike of the beds is north-60-degrees-east and the dip is 70 degrees southeast, showing that this is the south flank of the Bowers Mountain anticline.

Note that the color of the beds at this station is the same as at Station 12. The beds can be traced westward across Bowers Road at a point about 200 feet northeast of the bend in the road.

Station 12 (C-1)

This station is 4600 feet south 48 degrees west from the center of East Camp, at the crest of a short northeast-trending ridge which flanks the main Bowers Mountain trend. There is a pine forest in an abandoned farm area at the crest of the ridge and the station can be located by walking along the north edge of the pine forest to a location approximately 200 to 300 feet northeast of the highest point on the ridge.

At the station, a small ledge of rock crops out. It is medium gray and represents the lower portion of the Rose Hill lower-sandstone member.

The strike of the beds is north-62-degrees-east and the dip 40 degrees northwest. These beds can be traced east, around Paxton Peak (2300 feet east of this station) and then west to station 11 where the dip is south, thus showing the same rocks on both sides of the Bowers Mountain anticline.

Note that the sandstone at this exposure is medium gray rather than grayish-red as are the massive sandstones higher in the Rose Hill Formation.

Station 13 (C-2) and Station 14 (C-2)

These stations are in a short northwest-trending valley which is notched into the south slope of Bowers Mountain about 800 to 900 feet southwest of station 11, (about $1\frac{1}{4}$ miles south 38 degrees west from East Camp).

Outcrops on the slopes of the stream valley include both the upper and lower grayish red sandstones of the Rose Hill. The average strike of the beds is north-55-degrees-east and the dip is 68 to 70 degrees southeast.

The outcrops can best be located by reference to Laurel Run which flows along the base of the south slope of Bowers Mountain. The outcrop of the upper sandstone is about 750 feet northwest of Laurel Run.

The lower sandstone is 1150 to 1200 feet from Laurel Run. The outcrop of the lower sandstone can be traced continuously from station 11 southwest to station 14. The dip of this horizon varies from 70 degrees southeast to vertical.

Station 15 (C-1)

About $\frac{3}{4}$ mile west of West Camp, on the north slope of Bowers Mountain, the Tuscarora Trail trends southwest and then south up the unnamed stream valley, from the Valley Road. This station is located 3400 feet south of the road on a small northeast-trending ridge west of the Tuscarora Trail.

The outcrop is a grayish-red sandstone, and is the lower sandstone of the Rose Hill Formation.

Note that 800 feet northwest of this small ridge is a much larger ridge. The crest or top of the larger ridge is underlain by the Rose Hill upper sandstone, which is thicker and more massive than the lower sandstone and forms a larger ridge due to greater resistance to erosion.

Between the two sandstone ridges is a pronounced valley which trends along the mountain. The valley is underlain by about 350 feet of shale which comprises the middle of the Rose Hill Formation. Since the shale is less resistant to erosion than the two sandstones, it has been eroded more rapidly thus forming a valley.

South of this station is another small valley, where the shale of the lower Rose Hill Formation has been eroded more rapidly than adjacent sandstones.

South of the lower Rose Hill shale valley is the main part of Bowers Mountain which is underlain by the Tuscarora Sandstone which can be seen at station 1.

This sandstone is very resistant to erosion and thus underlies the highest ridges in the Perry County area such as Bowers, Blue, Conococheague, and Tuscarora Mountains.

Keefer Sandstone

Station 16 (B-4)

This station is located east of the Loysville Road on the east side of Shermans Creek about 500 feet south of the junction of Shermans Creek and Muddy Run, or, 300 feet south of the island present at the stream junction.

The light-gray Keefer Sandstone crops out on a steep slope which is a few tens of feet east of the stream. A few pine trees mark the site of the outcrop. The strike of the beds is north-47-degrees-east and the dip is 47 degrees southeast.

Station 17 (A-3)

This station is 750 feet north of the junction of the Loysville and Mumma Memorial roads. It is on a moderate slope in a wooded field corner.

Large blocks of light-gray Keefer Sandstone are scattered on the slope. The attitude (or strike and dip) of the beds is not clear, but the dip should be moderate toward the northwest since this station is located on the north flank or side of the Bowers Mountain anticline.

Station 18 (B-3)

On the Loysville Road, from a point 500 feet north of the east entrance to camp, one can look southwest along a fence row which separates wooded land from open fields. Station 18 can be any one of many localities along this fence row. The fence row can be reached by walking 500 to 1000 feet north-30-degrees-west from any point along the Mumma Memorial Road.

There are many boulders of light-gray to whitish-gray sandstone along the fence row. These boulders mark the line of outcrop of the Keefer Sandstone. One thing to note is that the Keefer cannot be cultivated due to its blocky nature. The field north of the fence row is underlain by the Mifflintown shale and limestone. In the Perry County region, cultivated areas are often limited in this manner by rock type.

The attitude of the rocks cannot be measured here, but the fence row is along the direction of strike and the dip is 20 to 30 degrees northwest.

Station 19 (B-3)

The location of this station is in East Camp, at a small borrow pit or excavation 200 feet northeast of Rotary Lodge on the east side of Shermans Creek.

The formation exposed is the Keefer Sandstone, which is interbedded with shale at this station. The average strike is north-63-degrees-east and the dip is 45 degrees northwest.

The total thickness of Keefer exposed is about 45 feet. The section consists of three medium-gray to dark-gray sandstone horizons, each several feet thick, separated by very fine-grained sandstone and olive-gray to dark-gray shale.

The rocks are fractured or jointed, and stained on the joint surfaces with rust-colored and black iron and manganese compounds. A golden-yellow mineral called iron-pyrite is present in minor amounts. Pyrite is a compound of iron and sulphur. Where found in minable quantities with other valuable minerals, sulphur is extracted from pyrite to make sulphuric acid. There is not enough pyrite in this area for such use.

Abundant marine fossils are present in the fine-grained shale beds between the upper and middle sandstone horizons. Those who visit this station may be able to find some.

The sandstone can be traced from this station southwestward across Shermans Creek to East Camp area at station 20.

Station 20 (B-2)

This station is in the center of East Camp. To find this station, cross Shermans Creek from east to west on the East Vehicle Bridge. The road turns northwest at the west end of the bridge for about 400 feet and then turns southwest. This station is on the slight incline of the southwest trend.

The rock, which shows as a line of medium gray boulders, is the Keefer Sandstone. As one goes southwest along the road, the Keefer is southeast of the road. The road goes diagonally across the Keefer outcrop, beyond which point the Keefer is west and then northwest of the road. The boulder trend can be followed southwest to the bank of Shermans Creek, where it crops out, dipping 50 to 60 degrees northwest.

Station 21 (B-2)

This station is on the east bank of Shermans Creek, 1600 feet southeast of the Valley Road Bridge in West Camp. The station is among some trees a few feet west of a field corner, on the south side of a small depression 10-feet deep which has been cut into the bank of Shermans Creek.

The rock which crops out is the Keefer Sandstone, and it shows the characteristic medium to light-gray color on the weathered surfaces. The strike is north-65-degrees-east and the dip is 60 degrees northwest.

The outcrop is not very large, but it is bedrock and illustrates the ease with which the Keefer Sandstone can be traced. The beds strike approximately along the fence row east of this station toward station 20 in the East Camp area.

Station 22 (D-2)

This station is located on the south side of Bowers Mountain about $1\frac{1}{4}$ miles southwest of East Camp in the same northwest-trending valley described under stations 13 and 14. The station can be located by pacing 470 feet up the valley from its junction with Laurel Run.

The light-gray Keefer Sandstone crops out on both sides of the valley and in the valley bottom. The beds are thick and well exposed. The strike is north-55-degrees-east and the average dip is 68 degrees southeast.

Station 23 (C-1)

One mile west of camp, the Tuscarora Trail follows the unnamed stream valley from the Valley Road up Bowers Mountain. This station is located along the Tuscarora Trail, 2300 feet south of the Valley Road. It can be recognized as the place where the stream valley becomes narrow as one walks from north to south.

The rock which crops out is the Keefer light-gray to brownish-gray sandstone. Many large blocks of Keefer clutter the valley of the small stream. The beds strike north-65-degrees-east (across the stream) and dip 30 to 35 degrees northwest. A zone of boulders which represents the Keefer outcrop can be followed northeast and southwest along the mountain from the station.

Miffintown Formation

Station 24 (B-3)

This station is located in East Camp about 550 feet northwest of the East Vehicle Bridge, along the east bank of Shermans Creek. It is on the northwest side of a shallow depression which is 150 feet wide.

The shale of the Miffintown Formation outcrops at station 24. It is medium to thin bedded, and the color varies from olive to medium gray. The shale is interbedded with beds which are dark brown and soft. These represent limestone beds from which the lime has been dissolved, leaving a residue of clay, rich in organic material.

The small valley south of station 24 is also underlain by Miffintown beds. These beds are less resistant to erosion than adjacent rocks, and

thus a small valley has developed where the Mifflintown outcrop should occur.

The strike of the beds is north-67-degrees-east and the dip is 45 degrees northwest. Note that this is similar to the strike and dip of the Keefer at station 19. The Keefer beds can be traced from station 19 southwest under the Rotary Lodge to the bank of Shermans Creek on the south side of the small valley at 24. It can be seen that the Keefer sandstone dips under the Mifflintown beds. Thus if a well were drilled at station 24, the drill would penetrate the Keefer approximately 200 feet below the surface of the ground.

Station 25 (B-2)

This station is located in East Camp. It is at the base of a gentle slope underlain by the Keefer Sandstone (station 20), and is the site of a slight depression. This depression is underlain by Mifflintown shale and limestone, the same as at station 24. Outcrop ledges are not present, but small fragments of yellowish weathering shale can be found in the soil. These are rock fragments which gradually are being decomposed in the soil forming process.

The strike and dip of the beds cannot be measured at this station but are the same as at station 20 where the Keefer Sandstone is seen dipping north under the McKenzie beds. When the excavation was made for the swimming pool in East Camp, the Mifflintown-Bloomsburg contact was exposed about half-way between the north and south ends of the pool.

Station 26 (C-1)

This station is located on the west bank of the unnamed stream located one mile west of camp. The station is approximately 1500 feet south along the stream from the intersection of the stream and the Valley Road.

Beds of the Mifflintown limestone and shale crop out on the west stream bank as shown in Figure 11. This station is of special interest because the beds exposed are folded or crumpled, and broken by small faults. At the north end of the outcrop the dip is steep northwest and at the south end it is steep southeast. Thus, the complete outcrop consists of an "up-fold" or anticline complicated by smaller folds and minor faults. Although this station illustrates the manner in which beds of rock can be folded, not all of the rocks in the camp area are folded as severely.

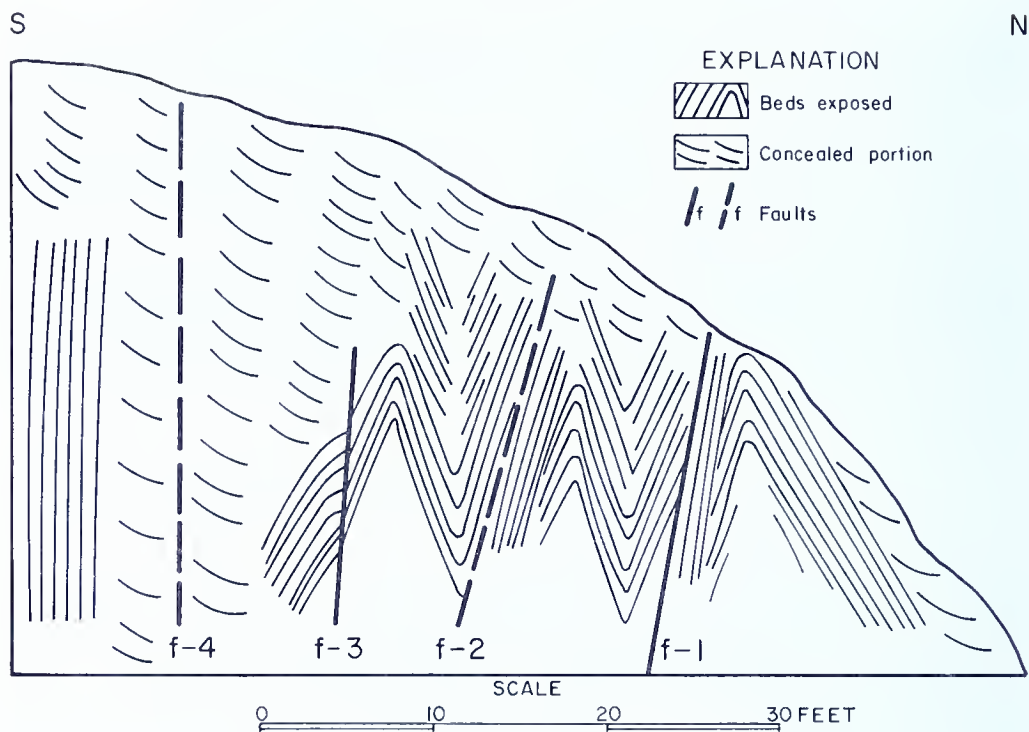


Figure 11. Station 26. Diagram of outcrop in stream bank, showing folded beds of Mifflintown limestone and shale.

Bloomsburg Formation

Station 27 (B-4)

This station is located nearly a mile east of East Camp on the east side of Shermans Creek. It can be located by walking 800 feet east along a dirt road from the north end of the Loysville Road Bridge, and then 1600 feet south along the east bank of Shermans Creek. Persons not wishing to cross Muddy Run at this spot can cross at the small bridge farther east along the road.

The bedrock exposed at the station is the light-gray Bridgeport Sandstone Member of the Bloomsburg Formation. The strike of the beds is north-52-degrees-east and the dip is 60 degrees southeast.

The traverse south along Shermans Creek to the station is interesting because half the thickness of the Bloomsburg red beds is well exposed. The dip varies from 38 to 80 degrees southeast. The Bridgeport Sandstone is located at the south end of the exposure.

Many joints or fracture surfaces are present in the red beds and are inclined nearly perpendicular, or at right angles, to the bedding. It is commonly difficult to distinguish bedding from joint surfaces where rocks have been deformed a great deal.

Station 28 (B-3)

This station is located on the west side of the Loysville Road, about 1500 feet south of the Loysville Road Bridge.

The rocks exposed are part of the red Bloomsburg Formation. The beds strike north-55-degrees east and dip 60 degrees southeast. Note the joint fractures which strike north-55 to 60-degrees-east and dip from 45 degrees northwest to vertical. When the joint fractures are very closely spaced (one inch or less) they are commonly called cleavage.

Note that by looking northeast along strike, one can see that these beds trend toward the red beds exposed along Shermans Creek north of station 27. If it were possible to clean all the soil and gravel from the bedrock in the valley of Shermans Creek, one could walk continuously on red beds from this station to those north of station 27. Thus, the red beds at one time extended as continuous layers across the present site of the valley and have been notched or eroded by Shermans Creek. The material that performs the eroding is not the stream water alone, but also the sand, gravel and mud carried and bounced along the stream bottom, especially in times of flood. Man's use of sandpaper to shape or mold working materials results from a lesson learned from the natural world, where sand and water have been shaping and wearing down mountains for millions of years.

Station 29 (A-3)

This station is located on the west side of the Loysville Road about 1200 feet northwest of the east entrance to camp. It is a small roadcut 200 feet north of a barn which is also on the west side of the road.

The beds exposed are the Bloomsburg red beds. The strike is north-65-degrees east and the dip is 48 degrees northwest. Note the crumpled, steeply dipping beds in the north half of the outcrop.

At the north end of the exposure are some greenish-gray and yellowish beds of shale and very fine-grained sandstone. There are also a few loose boulders of light-gray sandstone. These light-colored rocks probably represent the Bridgeport Sandstone Member, and if projected southwest along strike are seen to correlate with layers at station 31.

Station 30 (B-2)

This station is located about 700 feet northwest of the East Vehicle Bridge, along the east bank of Shermans Creek.

The rocks exposed are the red beds of the Bloomsburg, which make a steep slope and small cliff along the stream. The strike of the beds is north-67-degrees-east and the dip is 45 degrees northwest.

The contact between the Bloomsburg red beds and the Mifflintown medium gray limestone and shale (station 24) is exposed at the south end of the outcrop.

The Bloomsburg beds exposed can be traced continuously around the east end of Bowers Mountain to the beds exposed north of station 27. Note that here the beds dip 45 degrees northwest, whereas at station 27 the average dip is 60 degrees southeast. The beds at the two stations have opposite dip directions because they are on opposite sides of the Bowers Mountain anticline.

Station 31 (A-2)

The Bridgeport Sandstone Member of the Bloomsburg Formation is exposed at this station. It can be found easily by walking northwest along the top of the east stream bank for a distance of 360 feet from the Bloomsburg-Mifflintown contact. The whitish to light-gray sandstone is easily recognized among the red Bloomsburg debris. The beds are only partially exposed, but are probably 10 to 15 feet thick.

Station 32 (A-2)

This station is located north of East Camp, on the south side of the Valley Road about 3300 feet west of the Loysville Road. From this station, one can walk south down a steep dirt road in a narrow valley to Shermans Creek.

Along the west bank of the steep dirt road there is almost continuous outcrop of the Bloomsburg from the station to the flat valley-bottom along Shermans Creek. The strike of the beds is north-65-degrees-east and the average dip is 45 degrees north.

Note that the width of the Bloomsburg outcrop belt shown on the geologic map at this station is wider than normal. The extra width is due mainly to a small anticline or "upfold" between stations 30 and 32. The fold is a continuation of the one which is seen exposed to the southwest station 26. (See Figure 11).

Station 33 (B-2)

This station is located 1300 west of the west entrance to camp, along the Valley Road.

A moderately steep slope 10 to 30 feet high trends southeast from the road and parallel to Shermans Creek. Evidence of the Bloomsburg red shale and sandstone beds can be seen along this slope for a distance of 1200 feet southeast of the road. At some places bedrock crops out. In other places red soil can be seen, which indicates that the Bloomsburg Formation is near the surface under a thin cover of soil derived from this rock.

Station 34 (D-2)

This station is located in a stream valley on the south side of Bowers Mountain, $1\frac{1}{4}$ miles southwest of East camp. It is confined to the valley between the stream junction with Laurel Run and a point 300 feet north or up the small valley.

Bloomsburg red shale and sandstone crop out in the valley bottom. The strike of the beds is north-55-degrees-east and the dip is 68 degrees south. The contact between the Bloomsburg red beds and the underlying Mifflintown olive-colored beds can be seen at a point 300 feet from Laurel Run. The Mifflintown Formation beds at the contact are fine-grained sandstone and shale.

Persons interested can continue up the valley and see stations 22, 13 and 14.

Station 35 (B-1)

This station is $\frac{3}{4}$ mile west of West Camp area along the unnamed stream which flows down the north slope of Bowers Mountain. One can reach this station by pacing 1000 feet south along the stream, starting from the bridge where the Valley Road crosses the stream.

At this station, bedrock crops out along the steep west bank of the stream. Both sandstone and shale are present. Some of the sandstone is stained brownish on the surface, but when broken the fresh surface is a pale-olive brown, rather than red as are the shales at this outcrop. The light-colored beds are the Bridgeport Sandstone Member of the Bloomsburg red beds. This member can be seen also at stations 27 and 31.

The strike of the beds at station 35 is north-65-degrees-east and the dip is 35 degrees northwest. Compare the dip at this station with that at station 34 on the south side of the mountain where the dip is 68 degrees southeast. The dips are opposite and show that at one time the red beds extended over the present-day surface of Bowers Mountain. For millions of years, the rock has been decomposing into soil. As the soil forms it is carried away by rainwater and the action of streams. Gradually

the land surface will be worn away, until the mountains are reduced to small hills. Perhaps then another mountain-making period will occur and the process will begin again. It should be realized that these processes are very slow and require millions of years for significant changes.

Wills Creek Formation

Station 36 (A-3)

This station is located 2600 feet north of the east entrance to camp along the Loysville Road.

On the west side of the road, south of a farm lane, red and gray-green beds of shale are exposed. These beds are part of the Wills Creek Formation and differ from the Bloomsburg Formation, which is almost totally red as well as a deeper red.

Some of the Wills Creek gray-green beds at this locality are limy or calcareous and will fizz or bubble slightly when a drop of dilute hydrochloric acid is placed on the rock.

Note on the geologic map (Plate 2) that this formation underlies much of the area surrounding the Boy Scout Camp. A few small bean-shaped fossils (ostracods) are present at this station, although fossil collecting is much better in camp at station 19.

The strike of the beds at this station is north-55 to 60-degrees-east and the dip is 50 degrees northwest. North of this station, in the south part of Loysville, these same beds dip southeast. Thus the structure between station 36 and Loysville is a syncline or "down-fold."

Tonoloway Formation

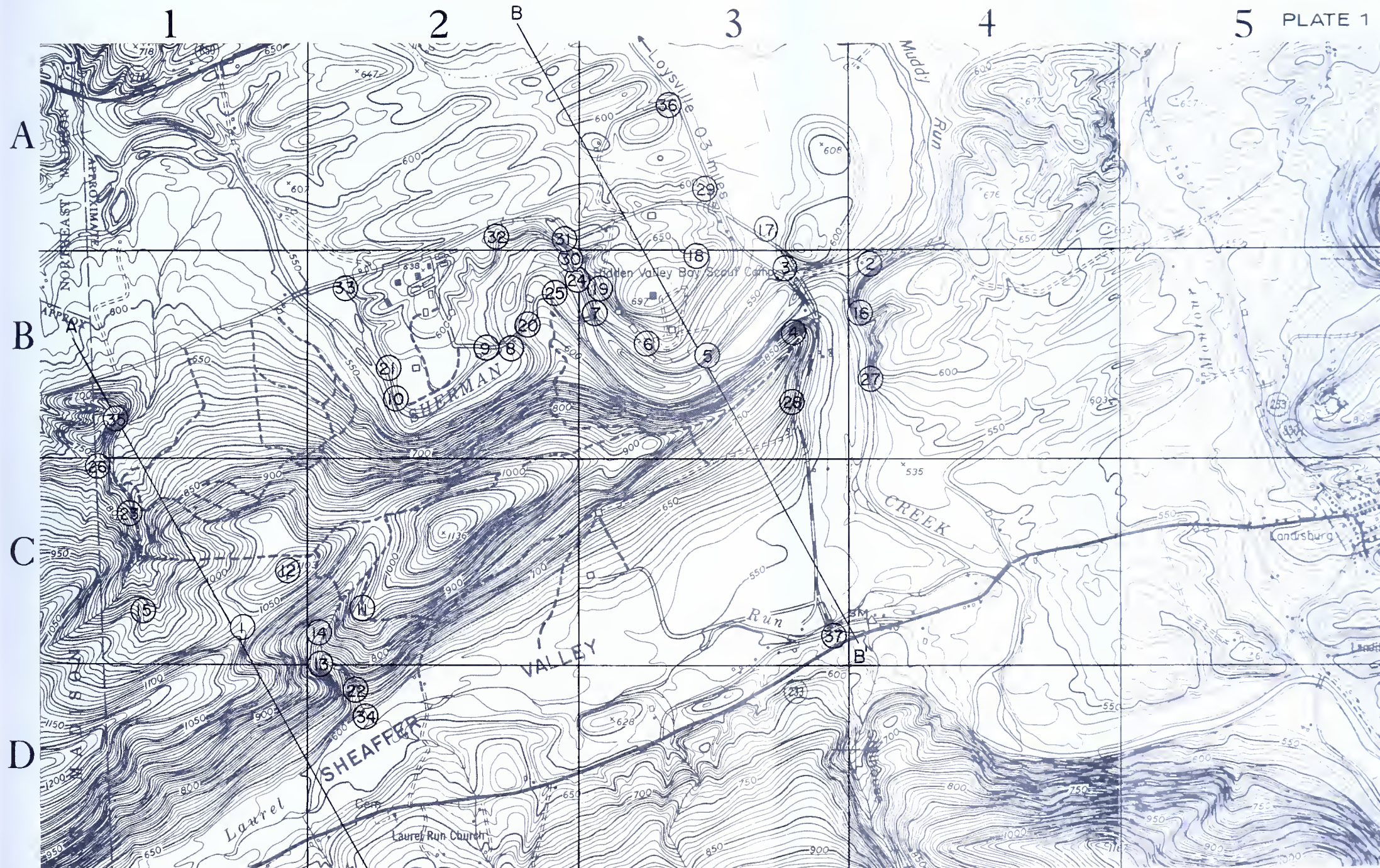
Station 37 (C-3)

This station is located south of Bowers Mountain, about 1¼ miles southeast of camp on the south side of the bridge across Laurel Run where the Loysville Road intersects the Landisburg Road. Bedrock is seen on the south side of the intersection.

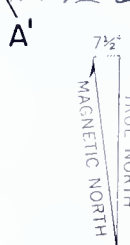
The rock which crops out is the greenish-gray to medium-gray Tonoloway Limestone. The limestone contains some clay and is not a good grade of limestone, but it is of interest because fossil mudcracks can be seen on the bedding surfaces. The beds dip northeast (toward the observer), and the bedding surface is broken by many intersecting lines resembling the cracks in a dry mud puddle. These cracks indicate that

when the limy sediments in the rock were being deposited, this station must have been near the shore of a sea, in shallow water. After the bed seen here was deposited, it was exposed to air by gentle raising of the coastal area or lowering of the sea level, perhaps at low tide. Exposure to air caused the sediments to dry out, forming mud cracks much the same as they form on the bottom of a pond which has been drained, or in a mud puddle in dry weather. Later, when the surface was covered with water again, lime mud was deposited in the cracks preserving them as they are seen today at this outcrop. It is interesting to realize that these mud cracks are approximately 350 million years old.

The surfaces of some of the beds at this station are covered with many small bean-shaped fossils called ostracods. Similar fossils are found also in the Wills Creek Formation.

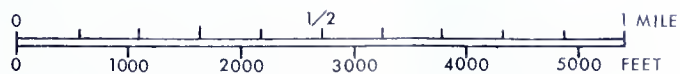


Taken from Landisburg 7 1/2' Quadrangle;
published by the U.S. Geological Survey.



APPROXIMATE MEAN
DECLINATION, 1952

SCALE 1:24,000



CONTOUR INTERVAL 10 FEET

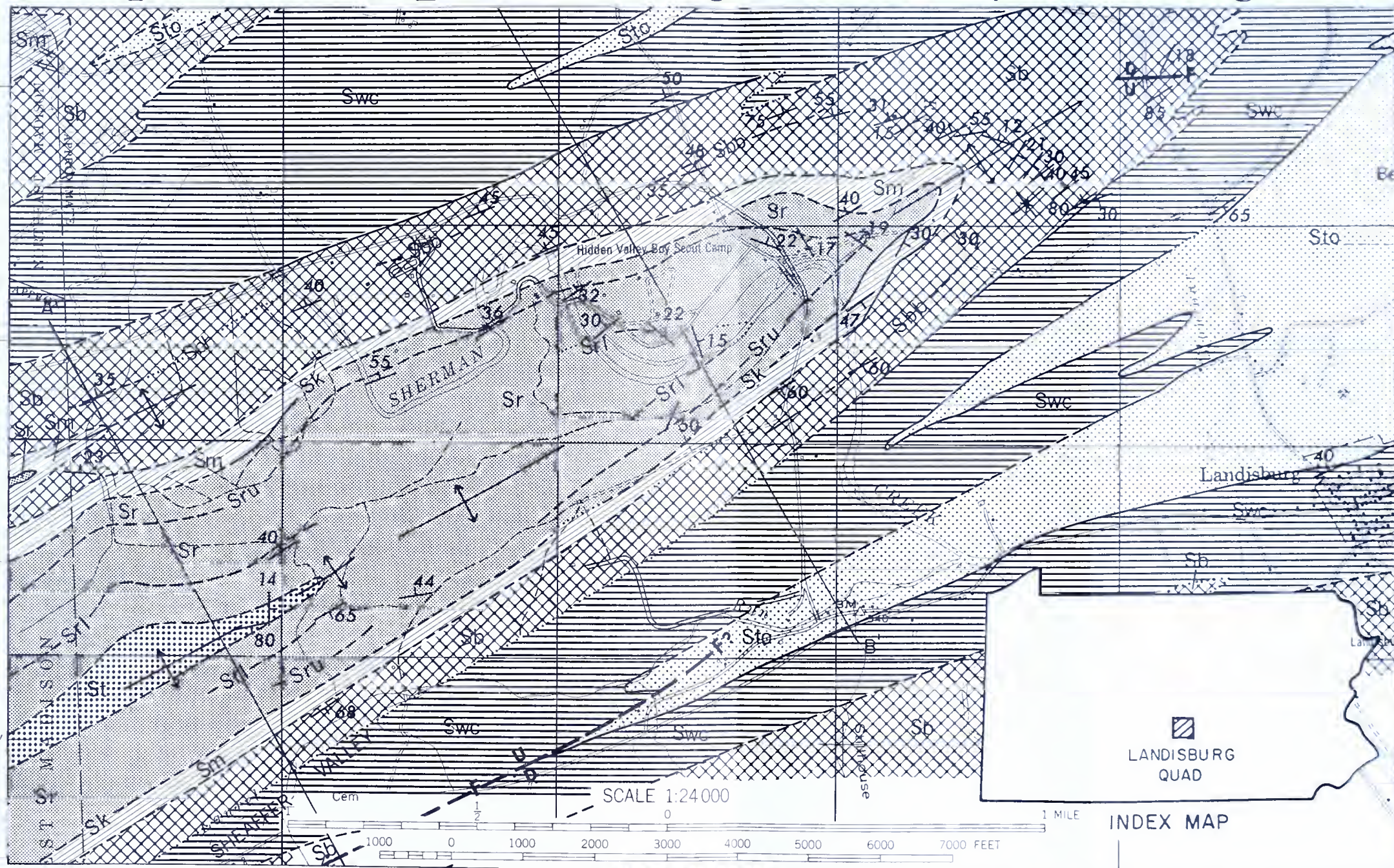
Topographic Map of the Hidden Valley Boy Scout Camp and vicinity , Perry County , Pennsylvania

A

B

C

D



EXPLANATION

Rock Formations

Sto Tonoloway Formation Gray limestone and calcareous shale	Sm Mifflintown Formation Gray limestone and shale
Swc Wills Creek Formation Shale, siltstone and argillaceous shale	Sk Keefer Sandstone
Sb Bloomsburg Formation Red shale and siltstone Sbb is the Bridgeport Sandstone member	Sr Rose Hill Formation Olive gray shale Sru is upper sandstone member Srl is lower sandstone member
	St Tuscarora Formation

Geologic Map Symbols

30 Strike and dip of beds	A—A' Line of cross section illustrated in Figure 9
↕ Axis of anticline	--- Contacts between rock formations Dashed where approximate Dotted where hidden
✱ Axis of syncline	--- Fault U is on upthrown side D is on downthrown side
St Tuscarora Formation	

